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TITLE: VEGETABLE PRESERVATION CABINET

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## CLAIMS

1. A vegetable preservation cabinet consisting of:

a space 7 that is partitioned into a suction space 7a and discharge space 7b by a gas separating membrane 6 which selectively transmits water vapor or carbon dioxide;

a flow controlling means, such as a fan 8 or pump, for controlling the flow of air inside said space 7;

a vegetable preservation vessel 4; and

an air composition adjusting means for adjusting the air composition inside said vegetable preservation vessel 4 to be suitable for the vegetables to be stored;

characterized in that the air suctioned into vegetable preservation vessel 4 from suction space 7a can be discharged from discharge space 7b.

## DETAILED DESCRIPTION OF THE INVENTION

### INDUSTRIAL FIELD OF APPLICATION

The present invention relates to a vegetable preservation cabinet that maintains the freshness of stored vegetables by regulating the air composition within the vessel for storing the vegetables.

### PRIOR ART

When storing vegetables, the preservation temperature and air composition within the preservation environment are extremely important factors. For most vegetables, the closer the temperature is to 0°C, the less deterioration there is in quality caused by the vegetable's respiratory activities. At the same time,

at such temperatures, it is possible to reduce withering due to transpiration of moisture, and limit the activity of putrefying bacteria. As a result, the preservation period can be extended. In addition, the amount of water vapor and carbon dioxide are important elements in the air composition within the preservation environment. For most vegetables, a suitable humidity level is in the range of 90~95%. In the case of carbon dioxide, the optimal concentration varies depending on the type of vegetable (tomatoes, for example, are in the range of 6~9%). Typically, however, higher carbon dioxide concentrations are efficacious to preservation, as the vegetable's respiratory activities are better controlled at these levels. In addition, an operation is required to remove the ethylene generated by the vegetables, as this can impair their preservation.

A conventional example of a vegetable preservation cabinet is shown in Figure 2. Namely, this vegetable preservation cabinet is designed such that a space 7, which is partitioned into a suction space 7a and a discharge space 7b by a gas separating membrane 6 which selectively transmits water vapor or carbon dioxide, a fan 8 for controlling the air inside suction space 7a so that it is taken up into a vegetable preservation vessel 4, and vegetable preservation vessel 4, are disposed within a cooling space 1. Vegetable preservation vessel 4 is open to the outside via suction space 7a and communicates with the outside via discharge space 7b.

The conditions for controlling the air composition within vegetable preservation vessel 4 will now be explained below.

When a vegetable 5 is stored inside vegetable preservation vessel 4, the air composition within the vessel becomes rich in water vapor, carbon dioxide and ethylene due to respiration and other such activities by vegetable 5. When fresh air 9 outside vegetable preservation vessel 4, in which the partial pressures of water vapor, carbon dioxide and ethylene are low, is introduced into vegetable preservation vessel 4, stale air 10 inside vegetable preservation vessel 4, in which the partial pressures of water vapor, carbon dioxide, and ethylene are high, is pushed to the outside of and expelled from vegetable preservation vessel 4. Stale air 10, with high partial pressures of water vapor, carbon dioxide, and ethylene, and fresh air 9, with low partial pressures of water vapor, carbon dioxide, and ethylene, flow toward one another in space 7 via gas separating membrane 6 which selectively transmits water vapor or carbon dioxide. At this time, water vapor or carbon dioxide are selectively separated according to their partial pressure difference, from stale air 10 where the partial pressures of water vapor, carbon dioxide, and ethylene are high, to fresh air 9 where the partial pressures of water vapor, carbon dioxide, and ethylene are low. Modified air 12, which has high partial pressures of water vapor and carbon dioxide but a low partial pressure of ethylene, is supplied into vegetable preservation vessel 4, while air 11, which has low partial pressures of water vapor and carbon dioxide and an unmodified ethylene content, is expelled to the outside of vegetable preservation vessel 4. Accordingly, the environment within vegetable preservation vessel 4 is maintained in a state that is suitable to the preservation of vegetables, namely, under conditions of high humidity and carbon dioxide concentration, with the ethylene that impairs preservation removed.

## Problems to be Resolved by the Present Invention

However, in this conventional example, respiration and other such activities by vegetable 5 are relied upon as the means for providing the air composition inside vegetable preservation vessel 4 with the high humidity or high carbon dioxide concentration that is suitable for vegetable preservation. Accordingly, the time required for the air composition within vegetable preservation vessel 4 to reach the optimal conditions for vegetable preservation will depend on the volume of vegetables contained therein. This presents a drawback, in that it may take from a few hours to a few days to create the appropriate environment.

The above-described conventional example is one type of CA (Controlled Atmosphere) storage, however, in general, more direct CA storage is performed. For example, OXYTROL storage may be cited. The OXYTROL method consists of a refrigerator, a nitrogen (inert) gas supplying device, and an oxygen concentration controlling device. In this method, nitrogen gas (or another such inert gas) is introduced into the refrigerator, thereby reducing the amount of oxygen within the refrigerator, and creating an oxygen-nitrogen ratio within the refrigerator that is suitable for the vegetables to be stored. This balance is automatically controlled, and this, combined with low temperature, provides improved storage effects.

OXYTROL storage makes it possible to provide an oxygen-nitrogen ratio that is suitable to the stored vegetables within a short period of time. However, OXYTROL storage lacks an operation to actively removed harmful substances such as ethylene.

In general, ethylene absorbing agents are often used to absorb harmful substances such as ethylene. However, these absorbing agents become saturated once they have absorbed a fixed quantity, so that their efficacy deteriorates or is lost after some point in time.

The present invention was conceived in consideration of the above-described circumstances and has as its objective the provision of a vegetable preservation cabinet that is capable of preserving vegetables over a long period of time in a fresh state by controlling the air composition within the cabinet.

## Means Employed to Resolve the Problem

The present invention's vegetable preservation vessel cabinet consists of a space 7, which is partitioned into a suction space 7a and said space 7b by a gas separating membrane 6 which selectively transmits water vapor or carbon dioxide; a flow controlling means such as a fan 8 or a pump, etc. for controlling the flow of air inside space 7; a vegetable preservation vessel 4; and an air composition adjusting means for adjusting the air composition within preservation vessel 4 so as to be suitable for the vegetables to be preserved; this vegetable preservation cabinet characterized in that air can be drawn up from suction space 7a into vegetable preservation vessel 4 while at the same time air is discharged from discharge space 7b.

## Effects

As a result of the above-described design, in the present invention's vegetable preservation cabinet, the air composition within vegetable preservation vessel 4 is adjusted to an optimal state using the air composition adjusting means, after which water vapor and carbon dioxide from discharge space 7b is supplied into suction space 7a via gas separating membrane 6 by means of causing the air inside vegetable preservation vessel 4 to flow into discharge space 7b and be expelled to the outside, while at the same time causing air from the outside to flow into suction space 7a. This water vapor and carbon dioxide are thereby introduced into vegetable preservation vessel 4 as conditions suitable for vegetable preservation, so that the inside of vegetable preservation vessel 4 can be maintained in an optimal state.

## Embodiments

An example of the present invention will now be explained based on Figure 1. Note that parts identical to those shown in Figure 2 will be assigned the same numeric symbol and an explanation thereof will be omitted.

Namely, as shown in Figure 1, this vegetable preservation cabinet is designed such that a space 7, which is partitioned into a suction space 7a and a discharge space 7b by a gas separating membrane 6 which selectively transmits water vapor or carbon dioxide, a fan 8 for controlling the flow of air inside space 7, and a vegetable preservation vessel 4, are provided within cooling space 1, so that air taken up from

suction space 7a into vegetable preservation vessel 4 is discharged from discharge space 7b. Further, an air composition adjusting means, i.e., vacuum pump 3, oxygen cylinder 13, nitrogen cylinder 14 and carbon dioxide cylinder 15, for pre-adjusting the air composition inside vegetable preservation vessel 4 so that it is suitable for the vegetables to be stored is connected to vegetable preservation vessel 4. Note that in this example, the present invention's vegetable preservation cabinet is disposed inside a cooled cooling space 1. This arrangement is markedly efficacious, however, it is not absolutely essential. Namely, the effects of the present invention's vegetable preservation cabinet can still be obtained even if it is not disposed within cooling space 1.

Next, the conditions for controlling the air composition within vegetable preservation vessel 4 will be explained below.

Vegetable 5 is placed inside vegetable preservation vessel 4. Stopcocks 4a, 4b and 2b of pipe 16, which connect vegetable preservation vessel 4 with each cylinder 13, 14, 15, the suction port of suction space 7a, and the discharge port of discharge space 7b, are closed. Stopcock 2a of pipe 17, which connects a vacuum pump and vegetable preservation vessel 4, is opened. Using vacuum pump 3, the air inside vegetable preservation vessel 4 is evacuated. Next, stopcock 2a is closed, and the degree of opening of stopcocks 2b, 2c, 2d and 2e of pipes 16, 18, 19, 20, which connect each cylinder 13, 14, 15 with vegetable preservation vessel 4, is suitable adjusted. The air composition inside vegetable preservation vessel 4 is adjusted to suite the preservation of vegetable 5a (5% oxygen, 5% carbon dioxide, 90% nitrogen, for example). Once the adjustment is accomplished, stopcock 2b is closed and stopcocks 4a, 4b are opened. Water vapor and ethylene are generated inside vegetable preservation vessel 4 as a result of respiration, transpiration and other such activities of vegetable 5. Employing fan 8, fresh air 9 from outside vegetable preservation vessel 4, having low partial pressures of water vapor, carbon dioxide and ethylene, is introduced into vegetable preservation vessel 4, while stale air 10 from inside vegetable preservation vessel 4, having high partial pressures of water vapor, carbon dioxide and ethylene, is expelled to the outside of vegetable preservation vessel 4. Within space 7, stale air 10 with high partial pressures of water vapor, carbon dioxide and ethylene, and fresh air 9 with low partial pressures of water vapor, carbon dioxide and ethylene, are made to flow toward each other via gas separating membrane 6 that selectively transmits water vapor and carbon dioxide. At this time, water vapor and carbon dioxide selectively separate according to their partial pressure difference from stale air 10, in which the partial pressures of water vapor, carbon dioxide and ethylene are high, to fresh air 9, in which the partial pressures of water vapor, carbon dioxide and ethylene are low. Modified air 12, in which the water vapor and carbon dioxide partial pressures are high and the ethylene partial pressure is low, is supplied into vegetable preservation vessel 4, while air 11 that includes low partial pressures of water vapor and carbon dioxide, and an unmodified ethylene content, is expelled to the outside of vegetable preservation vessel 4. Accordingly, the inside of vegetable preservation vessel 4 is maintained in a state that is suitable to vegetable preservation, namely, in a state of high humidity and carbon dioxide concentration, with the ethylene that can impair preservation removed.

Note that in addition to the fan that was employed as the flow controlling means for causing air to flow into vegetable preservation vessel 4, it is also acceptable to use a pump or the like.

The preceding embodiment demonstrated an example in which vacuum pump 3, and oxygen cylinders 13, 14, 15, etc. were used as the air composition adjusting means inside vegetable preservation vessel 4. However, any method or device may be thus employed, provided that it is capable of rendering the air composition suitable to vegetable preservation. For example, a method for introducing a combustion gas, or a method for introducing oxygen-poor air using an oxygen enriching film or a deoxygenating film, may be cited.

Provided that it is capable of selectively transmitting water vapor and carbon dioxide, then any functional film may be employed as gas separating film 6. For example, cellulose acetate film polysulfone film, polyether sulfone film, polyimide film, polydimethyl siloxane film, or polyamide film may be used.

## Effects of the Invention

As described above, the present invention makes it possible to pre-set the air composition within a vegetable preservation vessel. As a result, in addition to adjusting from the beginning the air composition to suit the preservation of vegetables within the vegetable preservation vessel, not only are the vegetables stored under high humidity and carbon dioxide concentration, but substances (ethylene) released from the vegetables that can impair preservation can be actively removed. As a result, it is possible to store vegetables over a long period of time while maintaining freshness.

## Brief Description of the Figures

Figure 1 is a cross-sectional view showing an example of the present invention. Figure 2 is a cross-sectional view showing an example of the conventional art.

1…cooling space, 2…stopcock, 3…vacuum pump, 4…stopcock, 5…vegetable, 6…gas separating membrane, 7…space, 7a…suction space, 7b…discharge space, 8…fan, 13…oxygen cylinder, 14…nitrogen cylinder, 15…carbon dioxide cylinder.